

CLAIMS

1. A method of making a magnetic read head which has an air bearing surface (ABS), comprising the steps of:

making a tunnel junction sensor including the steps of:

5 forming a ferromagnetic pinned layer structure with a magnetic moment;

forming an antiferromagnetic pinning layer exchange coupled to the pinned layer structure for pinning the magnetic moment of the pinned layer structure;

10 forming a ferromagnetic free layer structure with a magnetic moment;

forming a nonmagnetic electrically insulative barrier layer between the free layer structure and the pinned layer structure; and

forming the pinned layer structure or the free layer structure with an oxidized monolayer that interfaces the barrier layer.

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2. A method of making a magnetic read head as claimed in claim 1 wherein any oxidized monolayer is formed in a sputtering chamber with an oxygen partial pressure of 5×10^{-5} Torr.

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3. A method of making a magnetic read head as claimed in claim 2 wherein the pinned layer structure includes a cobalt based layer which is formed with said oxidized monolayer.

4. A method of making a magnetic read head as claimed in claim 3
25 wherein the cobalt based layer is cobalt iron (CoFe).

5. A method of making a magnetic read head as claimed in claim 4 including the steps of:

forming ferromagnetic first and second shield layers; and

30 forming the tunnel junction sensor between the first and second shield layers.

6. A method of making a magnetic read head as claimed in claim 1 wherein the step of forming the barrier layer includes the steps of:

forming at least a first portion of the barrier layer in an unoxidized state;

5 forming said at least a first portion of the barrier layer with an oxidized monolayer;

forming at least a second portion of the barrier layer in an unoxidized state on said oxidized monolayer of said at least a first portion of the barrier layer; and

oxidizing said at least first and second portions of the barrier layer.

10 7. A method of making a magnetic read head as claimed in claim 6 wherein any oxidized monolayer is formed in a sputtering chamber with an oxygen partial pressure of 5×10^{-5} Torr.

8. A method of making a magnetic read head as claimed in claim 7
15 wherein the barrier layer is formed of aluminum oxide (Al_2O_3) after oxidizing said at least first and second said portions of the barrier layer.

9. A method of making a magnetic read head as claimed in claim 8 wherein the pinned layer structure includes a cobalt based layer which is formed with
20 said oxidized monolayer.

10. A method of making a magnetic read head as claimed in claim 9 wherein the cobalt based layer is cobalt iron (CoFe).

25 11. A method of making a magnetic read head as claimed in claim 10 including the steps of:

forming ferromagnetic first and second shield layers; and

forming the tunnel junction sensor between the first and second shield layers.

12. A method of making a magnetic head assembly having an air bearing surface (ABS), comprising the steps of:

making a write head including the steps of:

5 forming ferromagnetic first and second pole piece layers that have a yoke portion between a pole tip portion and a back gap portion;

forming a nonmagnetic write gap layer located between the pole tip portions of the first and second pole piece layers;

forming an insulation stack with at least one coil layer embedded therein between the yoke portions of the first and second pole piece layers; and

10 forming the first and second pole piece layers at their back gap portions; and

making a read head including the steps of:

forming a first shield layer;

15 forming a tunnel junction sensor located between the first shield layer and the first pole piece layer;

making the tunnel junction sensor including the steps of:

forming a ferromagnetic pinned layer structure that has a magnetic moment;

20 forming an antiferromagnetic pinning layer structure exchange coupled to the pinned layer structure for pinning the magnetic moment of the pinned layer structure;

forming a ferromagnetic free layer structure which has a magnetic moment; and

25 forming a nonmagnetic electrically insulative barrier layer between the free layer structure and the pinned layer structure; and

forming the pinned layer structure or the free layer structure with an oxidized monolayer that is adjacent the barrier layer.

13. A method of making a magnetic head assembly as claimed in claim 12
30 wherein any oxidized monolayer is formed in a sputtering chamber at or less than 5×10^{-5} Torr/minute.

14. A method of making a magnetic head assembly as claimed in claim 13 wherein the barrier layer is formed of aluminum oxide (Al_2O_3) after oxidizing said first and second said portions of the barrier layer.

5 15. A method of making a magnetic head assembly as claimed in claim 14 wherein the pinned layer structure includes a cobalt based layer which is formed with said oxidized monolayer.

10 16. A method of making a magnetic head assembly as claimed in claim 15 wherein the cobalt based layer is cobalt iron (CoFe).

17. A method of making a magnetic head assembly as claimed in claim 16 including the steps of:

15 forming ferromagnetic first and second shield layers; and
 forming the tunnel junction sensor between the first and second shield layers.

18. A magnetic read head which has an air bearing surface (ABS), comprising:

20 a tunnel junction sensor including:
 a ferromagnetic pinned layer structure that has a magnetic moment;
 an antiferromagnetic pinning layer exchange coupled to the pinned
 layer structure for pinning the magnetic moment of the pinned layer structure;
 a ferromagnetic free layer structure which has a magnetic moment;
 a nonmagnetic electrically insulative barrier layer located between the
25 free layer structure and the pinned layer structure; and
 the pinned layer structure or the free layer structure having an oxidized
 monolayer that is adjacent the barrier layer.

30 19. A magnetic read head as claimed in claim 18 wherein the pinned layer structure includes a cobalt based layer that has said oxidized monolayer.

20. A magnetic read head as claimed in claim 19 wherein the cobalt based layer is cobalt iron (CoFe).

5 21. A magnetic read head as claimed in claim 20 including:
ferromagnetic first and second shield layers; and
the tunnel junction sensor being located between the first and second shield layers.

10 22. A magnetic head assembly having an air bearing surface (ABS),
comprising:

a write head including:

ferromagnetic first and second pole piece layers that have a yoke portion located between a pole tip portion and a back gap portion;

15 a nonmagnetic write gap layer located between the pole tip portions of
the first and second pole piece layers;

an insulation stack with at least one coil layer embedded therein located between the yoke portions of the first and second pole piece layers; and

the first and second pole piece layers being connected at their back gap portions; and

20 a read head including:

a first shield layer;

a tunnel junction sensor located between the first shield layer and the first pole piece layer;

the tunnel junction sensor including:

25 a ferromagnetic pinned layer structure that has a magnetic moment;

an antiferromagnetic pinning layer structure exchange coupled to the pinned layer structure for pinning the magnetic moment of the pinned layer structure;

a ferromagnetic free layer structure which has a magnetic moment; and

30 a nonmagnetic electrically insulative barrier layer located between the free layer structure and the pinned layer structure; and

the pinned layer structure or the free layer structure having an oxidized monolayer that is adjacent the barrier layer.

23. A magnetic head assembly as claimed in claim 22 wherein the pinned layer structure includes a cobalt based layer that has said oxidized monolayer.

24. A magnetic head assembly as claimed in claim 23 wherein the cobalt
5 based layer is cobalt iron (CoFe).

25. A magnetic head assembly as claimed in claim 24 including:
ferromagnetic first and second shield layers; and
the tunnel junction sensor being located between the first and second shield
10 layers.

26. A magnetic disk drive including at least one magnetic head assembly
that has an a write head, a read head and an air bearing surface (ABS) comprising:
the write head including:
15 ferromagnetic first and second pole piece layers that have a yoke
portion located between a pole tip portion and a back gap portion;
a nonmagnetic write gap layer located between the pole tip portions of
the first and second pole piece layers;
an insulation stack with at least one coil layer embedded therein located
20 between the yoke portions of the first and second pole piece layers; and
the first and second pole piece layers being connected at their back gap
portions; and
the read head including:
a first shield layer;
25 a tunnel junction sensor located between the first shield layer and the
first pole piece layer;
the tunnel junction sensor including:
a ferromagnetic pinned layer structure that has a magnetic moment;
an antiferromagnetic pinning layer exchange coupled to the pinned
30 layer structure for pinning the magnetic moment of the pinned layer structure;
a ferromagnetic free layer structure which has a magnetic moment;

a nonmagnetic electrically insulative barrier layer located between the free layer structure and the pinned layer structure; and

the pinned layer structure or the free layer structure having an oxidized monolayer that interfaces the barrier layer;

5 a housing;

a magnetic disk rotatably supported in the housing;

a support mounted in the housing for supporting the magnetic head assembly with said ABS facing the magnetic disk so that the magnetic head assembly is in a transducing relationship with the magnetic disk;

10 a spindle motor for rotating the magnetic disk;

an actuator positioning means connected to the support for moving the magnetic head assembly to multiple positions with respect to said magnetic disk; and

a processor connected to the magnetic head assembly, to the spindle motor and to the actuator for exchanging signals with the magnetic head assembly, for
15 controlling movement of the magnetic disk and for controlling the position of the magnetic head assembly.

27. A magnetic disk drive as claimed in claim 26 wherein the pinned layer structure includes a cobalt based layer that has said oxidized monolayer.

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28. A magnetic disk drive as claimed in claim 27 wherein the cobalt based layer is cobalt iron (CoFe).

29. A magnetic disk drive as claimed in claim 27 including:

25 ferromagnetic first and second shield layers; and

the tunnel junction sensor being located between the first and second shield layers.

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